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Effects of different strategies for feeding supplements on milk production responses in cows grazing a restricted pasture allowance

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ABSTRACT

Milk production responses of grazing cows offered supplements in different ways were measured. Holstein-Friesian cows, averaging 227 d in milk, were allocated into 6 groups of 36, with 2 groups randomly assigned to each of 3 feeding strategies: (1) cows grazed perennial ryegrass pasture supplemented with milled barley grain fed in the milking parlor and pasture silage offered in the paddock (control); (2) same pasture and allotment supplemented with the same amounts of milled barley grain and pasture silage, but presented as a mixed ration after each milking (PMR 1); and (3) same pasture and allotment, supplemented with a mixed ration of milled barley grain, alfalfa hay, corn silage, and crushed corn grain (PMR 2). For all strategies, supplements provided the same metabolizable energy and grain:forage ratio. [75:25, dry matter (DM) basis]. Each group of 36 cows was further allocated into 4 groups of 9, which were assigned to receive 6, 8, 10, or 12 kg of supplement DM/cow per day. Thus, there were 2 replicated groups per supplement amount per dietary strategy. The experiment had a 14-d adaptation period and an 11-d measurement period. Pasture allotment was approximately 14 kg of DM/d for all cows and was offered in addition to the supplement. Positive quadratic responses to increasing amounts of supplement were observed for yield of milk, energy-corrected milk (ECM), and fat and protein, and positive linear responses for concentrations of fat and protein for cows on all 3 supplement feeding strategies. No difference existed between feeding strategy groups in yield of milk, ECM, or protein at any amount of supplement offered, but yield and concentration of fat was higher in PMR 2 cows compared with control and PMR 1 cows at the highest amounts of supplementation. Responses in marginal ECM production per additional kilogram of supplement were also greater for PMR 2 than control and PMR 1 cows when large amounts of supplement were consumed. For all diets, marked daily variation occurred in ruminal fluid volatile fatty acids and pH, especially in cows fed the largest amounts of supplement. It was concluded that when supplements are fed to grazing dairy cows, a simple mix of grain and pasture silage has no benefit over traditional strategies of feeding grain in the parlor and forage in the paddock. However, yield of milk fat and marginal milk production responses can be greater if the strategy uses an isoenergetic ration that also contains alfalfa hay, corn silage, and corn grain.

Key words: partial mixed ration, pasture, milk response, supplement

INTRODUCTION

In many parts of the world, pasture is a significant source of nutrients for lactating dairy cattle. It is likely the numbers of dairy cattle maintained in full or partial grazing systems, or simply fed more forage, will increase in the future, given the increasing global demand for grain as sources of human food, animal feed, and fuel. Pasture, however, does not provide an optimal mix of nutrients for sustaining the high-producing dairy cow (Kolver and Muller, 1998). As a consequence, most grazing systems also incorporate supplementary feeds in the form of forage and grain or pelleted concentrates (Bargo et al., 2003; Wales et al., 2006). Reduced pasture availability due to low rainfall, in combination with management decisions to increase stocking rates or per-cow production, can further increase reliance on supplementary feeds to meet the nutritional needs of the milking herd (Armstrong et al., 2010). Choosing and implementing the most efficient and appropriate systems for providing such supplements from the wide variety available can be a challenge for dairy producers.

In southeast Australia, as well as other parts of the world, pasture is typically supplemented with grain or pelleted concentrates fed in the milking parlor. Production increases in response to supplements fed in this way can be good (Walker et al., 2001; Leddin et al., 2009), but responses are curvilinear, with poorer responses being observed as the amount of grain increases (Stockdale et al., 1987; Walker et al., 2001; Kellaway and Harrington, 2004). Noticeable reductions in milk

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production responses have been reported when pasture is supplemented with more than 5 to 9 kg of grain DM/cow per day, depending on stage of lactation and pasture quality (Walker et al., 2001; Beever and Doyle, 2007). It is well established that cows can consume much more grain than this and produce large quantities of milk with no untoward health effects, so such diminishing responses to supplements may be due in part to inefficiencies in rumen fermentation when large amounts of grain are ingested quickly (Dixon and Stockdale, 1999; Wales et al., 2000). Feeding large amounts of cereal supplements in the parlor can increase variations in rumen fluid pH and the time each day that pH is below 6.0 (Wales and Doyle, 2003), which can, in turn, impair NDF digestion (Mould et al., 1983; Leddin et al., 2010) and thus reduce milk production responses (Doyle et al., 2005). Feeding grain can also lead to substitution effects, whereby less herbage is consumed, thus further reducing the observed milk production response to increased supplementation (Dixon and Stockdale, 1999).

An alternative method of feeding large amounts of supplements to grazing dairy cows is to feed them as a partial mixed ration (**PMR**), which is defined as a TMR fed to cattle on a feed pad between bouts of grazing (Bargo et al., 2002). A well-formulated PMR that is consumed over a longer period of time during the day than when grain is fed in the parlor could lead to a more stable ruminal fermentation with less variation and lower declines in rumen fluid pH. For this reason, it has been suggested that providing supplements to grazing cows as a PMR may lead to improved milk production responses compared with feeding concentrates in the parlor (Beever and Doyle, 2007). However, we do not have a full definition of the range of potentially useful supplementation strategies.

The objective of this experiment was, therefore, to evaluate the efficiency of different strategies for feeding supplementary forage and grain to grazing cows. Specifically, strategies that incorporated 2 differently formulated PMR were compared with the traditional strategy of feeding grain in the parlor and forage in the paddock. The hypotheses tested were as follows: (1) increasing the amounts of grain fed in the milking parlor and forage supplement fed in the paddock to cows in late-lactation grazing a low allowance of fall pasture would lead to a quadratic increase in production of ECM; (2) feeding the same amounts of the same concentrate and forage supplements, but as a simple PMR, to cows in late-lactation grazing a low allowance of fall pasture would lead to a linear increase in ECM production, and the marginal ECM production response would be greater than if the supplements were fed separately in the parlor and paddock; and (3) increasing the amounts of a PMR formulated to be isoenergetic, but containing a slowly digestible starch source, would also lead to a linear increase in ECM production, and marginal ECM production response to additional supplement would be greater than for the simple PMR. Inherent in these hypotheses is that part of any negative or diminishing returns would be an altered pattern of rumen fermentation and pH.

MATERIALS AND METHODS

Cows and Design

The experiment was conducted in late fall at the Department of Primary Industries (**DPI**), Ellinbank Centre, Victoria, Australia (latitude 38°14′S, longitude 145°56′E). All procedures were conducted in accordance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (National Health and Medical Research Council, 2004). Approval to proceed was obtained from the DPI Agricultural Research and Extension Animal Ethics Committee.

The experiment used 216 multiparous seasonally calving Holstein-Friesian dairy cows (Table 1), including 24 rumen-fistulated cows. All cows were between 3 and 7 yr old (in their second to fifth lactation) and were milked twice daily at ca. 0700 and 1500 h. Cows had calved in late winter/early spring and were an average of 227 DIM (range 177 to 256 DIM). All cows were weighed immediately before the experiment.

The experiment was conducted over 25 d. This included a 14-d preexperimental period during which cows adapted to the amount of supplement. After the preexperimental period, there was an 11-d measurement period during which DMI and milk production were measured.

Supplement Feeding Strategies

As soon as all cows had calved, they were allocated into 6 groups of 36 cows balanced for DIM, age, BW, and production of milk, milk protein, and milk fat in the previous lactation according to the method of Baird (1994; Table 2). Each group included 4 rumen-fistulated cows. One of 3 feeding systems was then randomly assigned to 2 of the 6 groups. The feeding systems were as follows:

(1) Control: cows grazed perennial ryegrass (*Lolium perenne* L.) pasture supplemented with milled barley grain fed twice daily in the milking parlor and pasture silage provided in the paddock. The ratio of grain:forage fed as supplement was 0.75:0.25 (DM basis). The pasture allowance was approximately 14 kg DM/cow per day;